



Canadian Space Agency
Agence spatiale canadienne



Seismic Refraction Experiment at the McGill Arctic Research Station

Marie-Claude Williamson, Krystal Aubry, Josef Sliwinski,
Canadian Space Agency

Claire Samson
Carleton University

Canada



Introduction

Objective: to illustrate seismic survey methods for the Canadian Space Agency's *Educators Project in the North*, at the McGill Arctic Research Station (M.A.R.S.), Axel Heiberg Island, from July 21 to 31, 2008. The SmartSeis instrument and geophones [4] were acquired by the Division of Planetary Exploration in April 2008. The surveys will enable participants to:

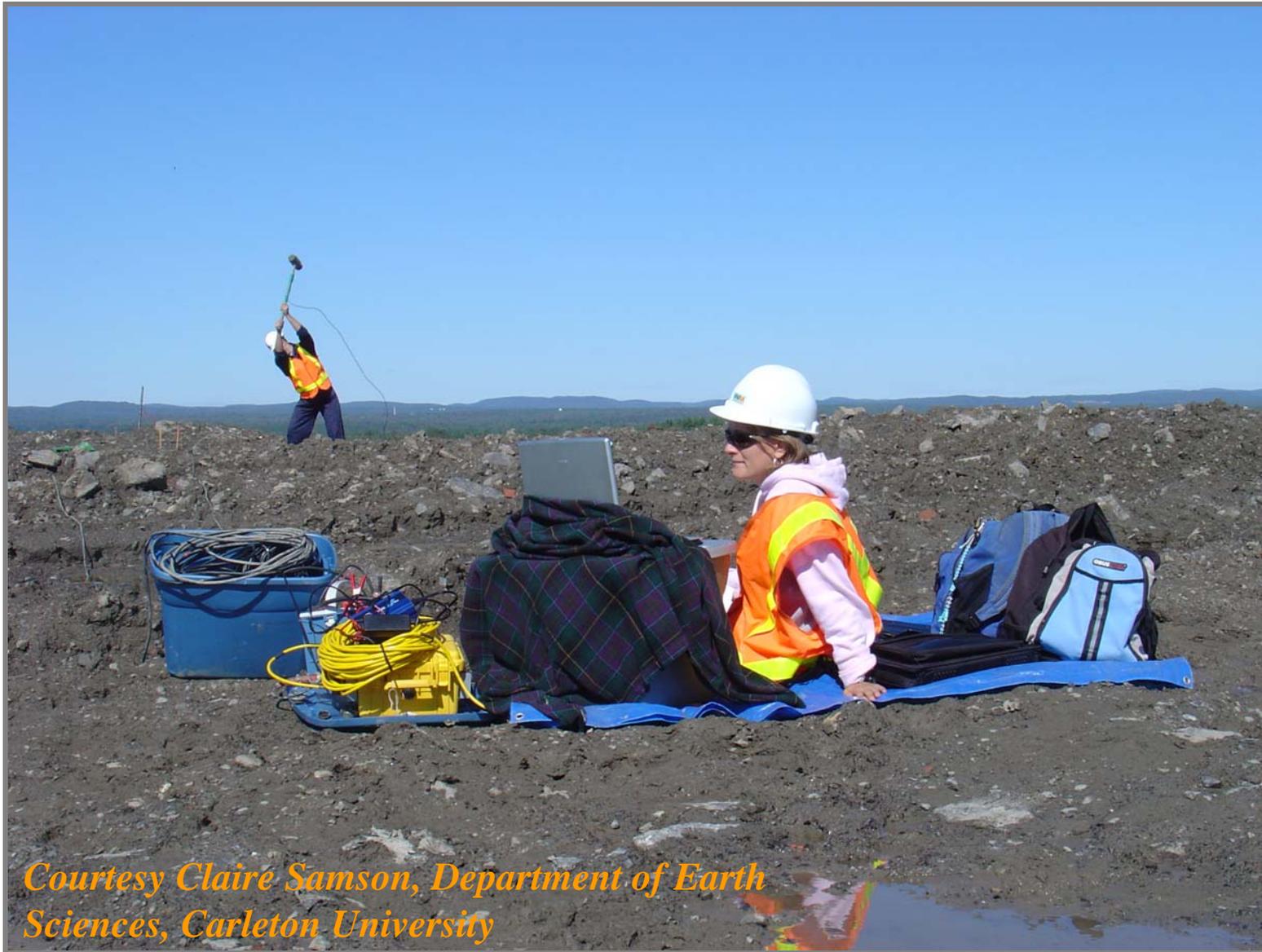
- become familiar with seismic methods
- carry out reconnaissance geophysical work at Expedition Fiord
- draw comparisons with lunar missions
- define classroom activities while contributing to future surveys at the M.A.R.S. base camp.

M-C Williamson will present an overview at a teleconference scheduled for July 15, 2008.



Seismic Surveying

In seismic surveying, seismic waves are created by a controlled source and propagate through the subsurface. Some waves will return to the surface after refraction or reflection at geological boundaries within the subsurface. Instruments distributed along the surface detect the ground motion caused by these returning waves and can record *the arrival times of the waves* at different ranges from the source. These travel times may be converted into depth values and, hence, the distribution of subsurface geological interfaces may be systematically mapped [1].



Courtesy Claire Samson, Department of Earth Sciences, Carleton University



Seismic Instrument [4]

Seismograph and Battery



Geophones



Hammer and Strike Plate





Seismic Refraction Survey

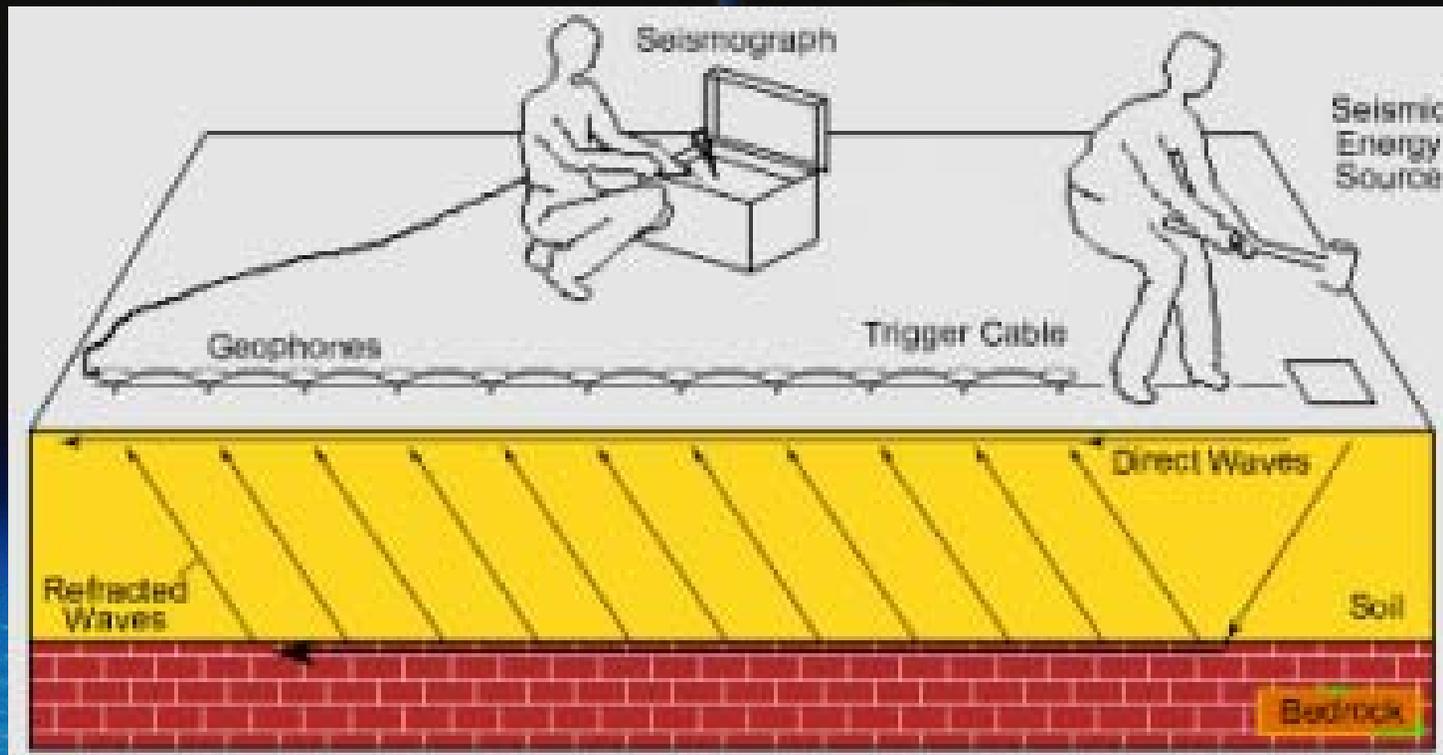
A seismic refraction survey makes a cross section of geologic layers by measuring the travel time of vibrations through the ground. The survey proceeds by generating sound waves in the earth by striking a hammer on a plate on the ground on at least two locations. The hammer point is indicated on the following diagram by a (*).



Source: [http:// www.geosphereinc.com](http://www.geosphereinc.com)



Seismic Refraction





Procedure

- 1. Define the geometry of the survey line(s)**
- 2. Check all equipment**
- 3. Insert the geophones in the ground in a straight line at a suitable interval**
- 4. Connect the geophones and hammer switch correctly to the seismograph**
- 5. Make sure the seismograph is operating and set up**
- 6. Strike the hammer on the strike plate at the correct location**
- 7. Identify distinct first arrivals on the seismograph**
- 8. Repeat steps 4 and 5 by moving the hammer to new locations along or off the end of the line of geophones**



Quality Control (QC)

You can recognize the first arrivals of energy by looking for the **first point** where the trace changes from a straight line to a wiggle. The diagram on the next slide shows what the pattern of first arrivals usually looks like. Each pattern differs in detail because of different soil and geological conditions.



Shot Gather

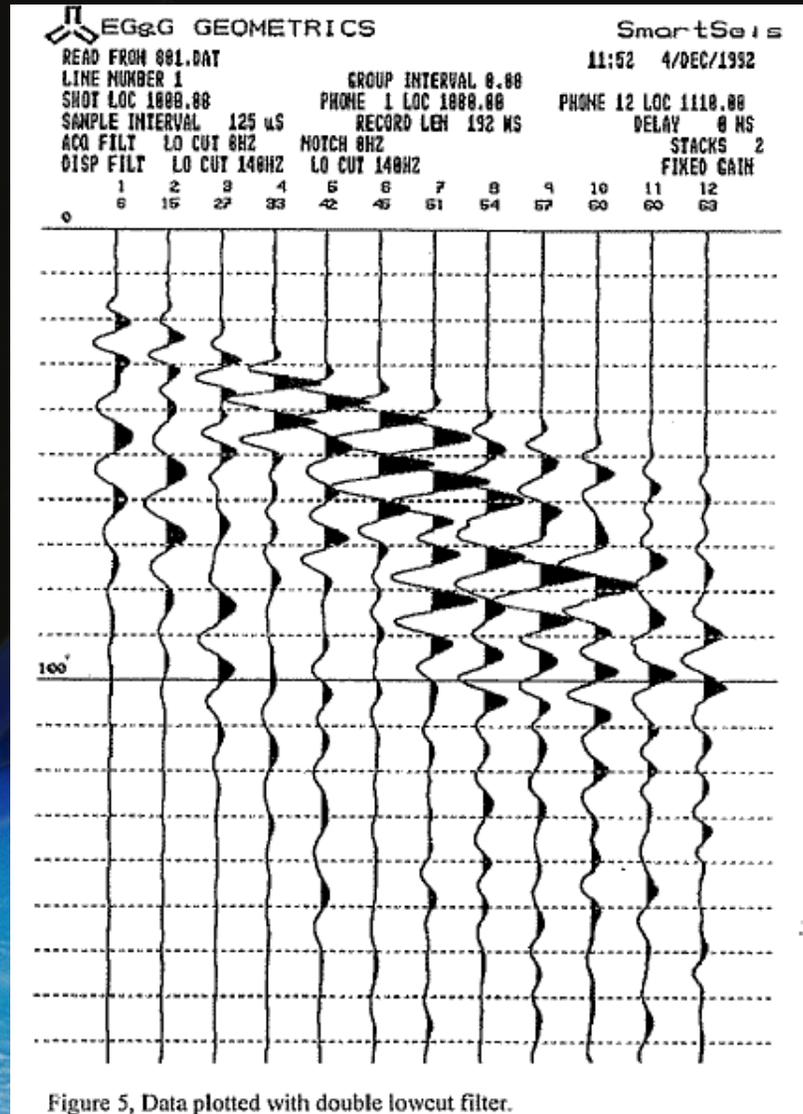
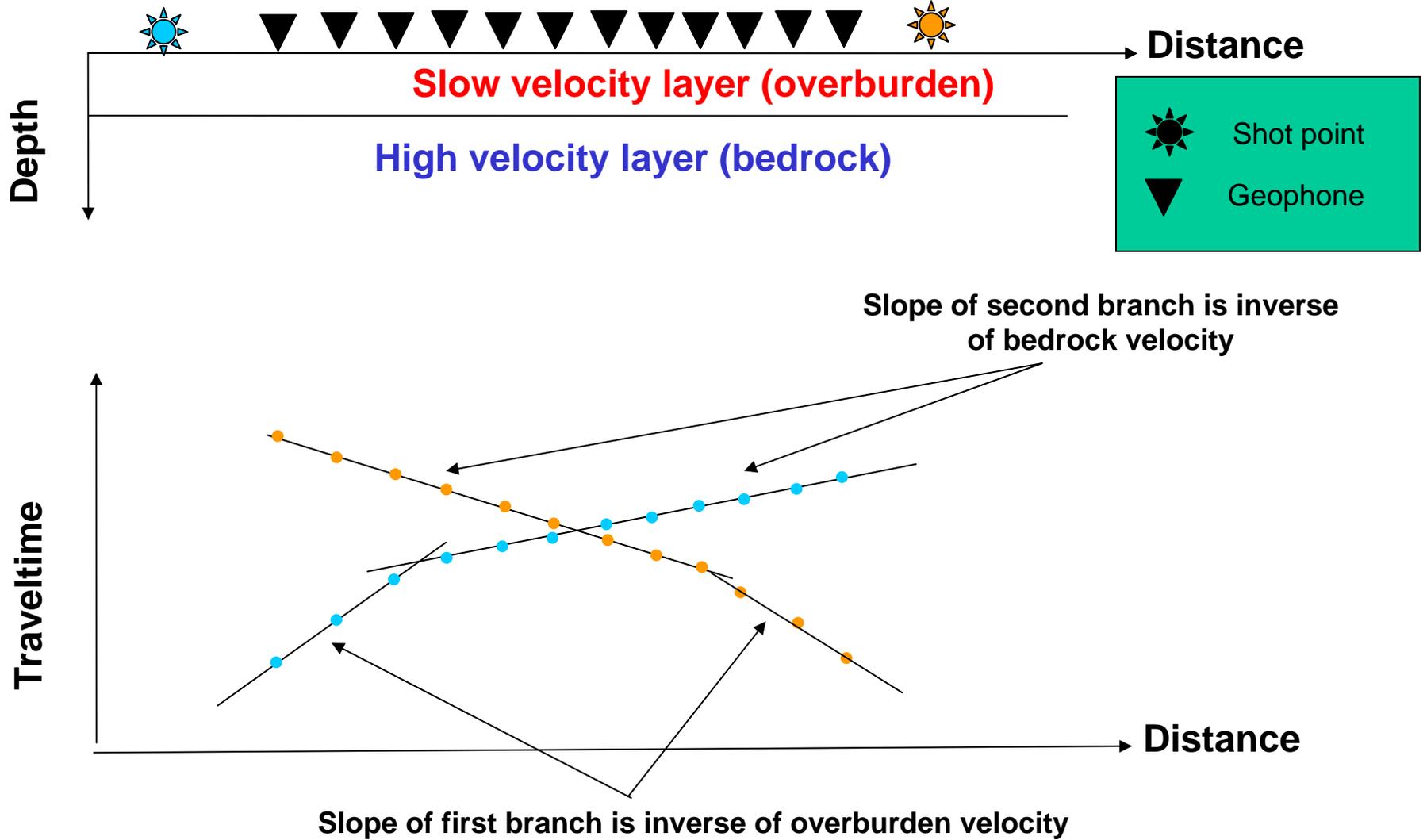


Figure 5, Data plotted with double lowcut filter.



Quality Control





Site selection



Volcanic and sedimentary rocks of the Sverdrup Basin [5, 6]



Purpose of the Survey

- **Depth to bedrock: 2-layer model**
- **Instrument performance in remote setting and lunar analogues**
- **Data quality**
- **Team operations**
- **Lessons Learned**



References

- [1] Keary, Brooks and Hill (2007) An Introduction to Geophysical Exploration
- [2] Walker and Cohen (2006) The Geoscience Handbook American Geological Institute, Section 3.2
- [3] Neuendorf, Mehl, and Jackson (2005) Glossary of Geology, American Geological Institute
- [4] <http://www.terraplus.ca/products/seismic/smartsei.htm>
- [5] W. Pollard, L. Whyte, D. Andersen, C. Omelon, T. Niederberger, N. Perreault, M. Eccelstone, and T. Haltigin (2007) Trento Workshop, Italy
- [6] NTS 59H Map 1301A Strand Fiord 1:250,000
<http://gdr.nrcan.gc.ca/mirage/>